Voiceless messengers, or hot news long distance

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Aeschylus' *Agamemnon* opens in the twilight just before dawn. Uncomfortably stationed on the palace roof a servant prays for an end to the tedious vigil imposed on him by Clytaemestra a year ago: it is his duty to watch for the fire-signal bringing news of Troy's fall. His prayer is swiftly answered:

> *Hail, lamp that shows by night the light of day,*
> *and ordains the setting up of many dances*
> *in Argos for the sake of this event!*
> *Hurrah, hurrah!*
> *To Agamemnon's wife I give clear signal,*
> *that she may rise from her bed in all speed*
> *and raise a jubilant cry of thanksgiving at this torch,*
> *if truly the city of Ilium*
> *is taken, as the beacon's light announces.*
> (*trans.* Lloyd-Jones)

As we share the watchman's jubilation we may not stop to think about practical details. But as the crow flies Troy is some 220 kms from Argos: did Aeschylus expect his audience to support that a bonfire lit on Mount Ida might be visible at Argos?

No such suspension of unbelief is required of us. In response to the questions of the Chorus of Argive elders, who are puzzled by the Queen's confidence in news of which they have heard nothing, Clytaemestra describes a chain of fires lit on the mountain tops of Ida, Lemnos, Athos, Peparethus, Euboea, Messapium, Cithaeron, the Megarid, and Mount Arachnaeum, neighbouring Argos. (The stages get shorter as we get nearer the area with which Aeschylus' audience might be supposed to be familiar.) Sceptical at first, the Chorus is at length convinced.

Line management

The watchman had spoken of Clytaemestra's 'man-counselling heart', and we cannot fail to be impressed by the organizational talent demonstrated by the success of this telegraph system. It has political implications: Agamemnon must be supposed to control the regions where the beacons are situated, or at least to be on good terms with their rulers. The practical details of the bonfire chain would call for close attention. The construction of suitable piles of brushwood would take time. Reliable watchmen would have to be recruited (surely at least a pair for each beacon), and kept supplied; their duties would not of course consist simply in scanning the far horizon for the flame which meant victory and duly relaying the message, but they would need to protect their beacon from damp and keep ready a well controlled small fire to light it (we too easily take for granted the convenience of matches). All this, it seems, Clytaemestra has prepared quite unbeknownst to the Elders, though they are supposed to serve as a kind of Council of State in Agamemnon's absence. We are left in no doubt who is in charge at Argos.

Where did Aeschylus get this marvellous idea? He owes to the *Odyssey* the watchman and his year-long vigil, though there its object is the returning Agamemnon of whose approach Clytaemestra's lover Aegisthus wants early warning. But the beacon chain seems to have been suggested by a Persian example some twenty years before the *Agamemnon*'s production when Mardonius was left in Greece in 479 as commander-in-chief after Xerxes' return to Asia. According to Herodotus one of the reasons why he was particularly keen to recapture Athens was that 'he planned to signal his capture of the town to the king in Sardis by a chain of fire-signals through the islands'. The last three words are misleading: Greek command of the sea after Salamis would have prevented Mardonius arranging a line of beacons straight across to Sardis by way of the Cyclades. A route closer to that of the *Agamemnon* would be required, passing along the European coast to Athos, and then by way of Lemnos to Asia. The administration of a far-flung empire requires well organized communications. Xerxes' capture of Athens in 480 leads Herodotus to describe the Persian overland courier system, which has provided the US Mail with its motto. 'Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.' The Mardoniograph offered a potential advantage in speed but depended on favourable weather conditions and was clearly of limited usefulness if it was dedicated to conveying a single prearranged message. As in the *Agamemnon*, that message should bring joy to the recipients.

More commonly fire-signals convey a warning and/or an appeal for help, as in a striking simile which marks a turning point in the narrative of the *Iliad* when Achilles shows himself to the Trojans and by his mere appearance inspires panic: 'As when the smoke rises up from a city to reach the sky, from an island in the distance, where enemies are attacking and the inhabitants run the trial of hateful Ares all day long, fighting from their city: and then with the setting of the sun the light from the line of beacons blazes out, and the glare shoots up high for the neighbouring islands to see, in the hope that they will come across in their ships to protect them from disaster – such was the light that blazed from Achilleus' head up into the sky' (*Iliad* 18. 207–213, *trans.* Martin Hammond).

Beyond SOS

The Greeks held that fire-signals were invented during the Trojan War by the ingenious Palamedes, Odysseus' rival in brains and his superior in integrity. But we might have expected the basic idea to occur very quickly to any group who had achieved control of fire, though evidence for it is inevitably elusive. With the evolution of a command structure its usefulness could be extended beyond an unspecific *SOS/Danger!*

Documentary evidence for the operation of a fire-signalling system long before the Trojan War, in nineteenth-century Mesopotamia, comes to us from the palace archives of the Old Babylonian city of Mari, on the banks of the Tigris. The following letter indicates a highly organized system, even if there were problems:

'Yesterday I went out from Mari and spent the night in Zurubban; and the Yaminites all raised torches: from Samanum to Ilum-muluk, from Ilum-muluk as far as Mishlan. All the towns of the Yaminites in the district of Terqa raised their torches in reply. Now, so far I have not managed to find out the reason for those torches, but I shall try to find out the reason and I shall write to my lord the result. But let the guards of Mari be strengthened, and may my lord not go out of the gate!' (*trans.* Stephanie Dalley). From another letter we learn that two torch signals meant 'Come quickly to help', whereas a single signal could have more than one meaning. Attractive as such swift communication across the Mesopotamian plains must have seemed, its usefulness was limited not only by its inflexibility but also by climatic conditions (dust-storms as well as rain would render it useless) and, of course, by the fallibility of a watchman less conscientious than Clytaemestra's servant.

Returning to the fifth century and the Greeks, we observe that torch-signalling had developed a menu. This may be illustrated from Thucydides' detailed and vivid narrative of the escape of some two hundred men from the beleaguered city of Plataea in 428. As soon as the besieging force realized what was going on, they raised torches in the direction of Thebes, indicating danger; but the Plataeans within had anticipated this and raised further torches to confuse the signal. This implies a system capable of expressing more than 'Help! Danger!'; otherwise the addition of the Plataean torches would merely have underlined the urgency of the appeal. We must infer that the besiegers had been using such signals for some time, for different, pre-arranged messages, and that the Plataeans had cracked the code.

But clearly the menu of pre-arranged messages must be rather restricted. Polybius, writing in the mid-second century, describes a system allowing the transmission of any message whatever. He attributes the basic idea to the otherwise unknown Cleoxenus and Democlitus, but he has himself, he says, improved it. 'We take the alphabet and divide it into five parts, each consisting of five letters. There is one letter less in the last division, but this makes no practical difference.' Thus:

Α	Ζ	Λ	Π	Φ
Β	Η	Μ	Ρ	Χ
Γ	Θ	Ν	Σ	Ψ
Δ	Ι	Ξ	Τ	Ω
Ε	Κ	Ο	Υ	–

'Each of the two parties who are about to signal to each other must now get ready five tablets and write one division of the alphabet on each tablet, and then come to an agreement that the man who is going to signal in the first place is to raise two torches and wait until the other replies by doing the same. This is for the purpose of conveying to each other that they are both at attention. These torches having been lowered the dispatcher of the message will now raise the first set of torches on the left side indicating which tablet is to be consulted, i.e. one torch if it is in the first, two if it is in the second, and so on. Next he will raise the second set on the right on the same principle to indicate what letter of the tablet the receiver should write down' (*trans*. W. R. Paton). (We might feel that it was unnecessary to advise the signaller to 'choose words which will convey what he means in the smallest number of letters.') Polybius sees this innovation in telecommunications as an example of a very far-reaching development: 'In offering these observations', he concludes, 'I am acting up to the promise I originally made at the outset of this work. For I stated that in our time all arts and sciences have so much advanced that knowledge of most of them may be said to have been reduced to a system. This is, then, one of the most useful parts of a history properly written.'

How would Polybius' system compare with a modern one? Well, a modern system would be based on binary arithmetic. A binary 1 (torch burning) and a binary 0 (torch not burning) would allow the transfer of one bit of information, i.e. two possible messages. They might mean 'hostile forces approaching' or 'nothing to report'. With five torches it would be possible to give $2^5 = 2x2x2x2x2 = 32$ different messages. Thus, for example, if out of five torches in a line the second one and the fifth one are burning, that would correspond to the binary signal 01001, and could represent one of the letters of the alphabet. The conclusion is that a modern system could do the same thing with five torches whereas Polybius needed as many as ten. However, if we look at the chances of correctly decoding the information at the receiving end we can see that Polybius' system is far superior to the one proposed above. The binary system is fine for modern times when the foundation blocks of communications systems consist of electronic circuits and it is easy to determine whether a current flows (binary 1) or not (binary 0) in a particular circuit. But if we have to rely on torches it is much more difficult to say whether it is torch number 2 or torch number 3 which is alight. The beauty of Polybius' system is that only those torches need to be counted which are burning bright.

Why the Roman empire fell

An experiment some years ago by students at the Aachen Technical University showed that Polybius' system allows a rate of transmission of c. 8 letters a minute. Was it ever put to practical use? Apparently not, though its technical difficulties would not have defeated ancient engineering skills. According to modern estimates relay stations 1 km apart would be needed. The construction and maintenance of such a system would have been far too expensive in Polybius' time, but not beyond the material resources and engineering skill of the Roman empire in the prosperous second century A.D., the age of Antoninus Pius and Marcus. Had they built such a communications system the imperial administration would have been better run, centrifugal forces would have been better contained, and, in particular, troop movements would have been better directed. And the consequences? Who knows? Britain might still be part of the Roman empire.

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